Technical Memorandum - Revision 2

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Process Areas (OU-3) Sub-Surface Utility and Dry Well Investigation

Yerington Mine, Yerington, Nevada

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Geonics EM-31 terrain conductivity meter used near the Assay Laboratory in an effort to locate a backfilled excavation, piping or dry well.

Table of Contents

List of Figures

List of Tables

Attachment A: Reference Documents

1. Introduction

This Technical Memorandum, requested by the U.S. Environmental Protection Agency - Region 9 (EPA) via e-mail to Atlantic Richfield Company (ARC) on October 7, 2010, provides additional information regarding a sub-surface utility and dry well investigation in the Process Areas Operable Unit (OU-3) of the Yerington Mine Site (Site). The investigation is described in Section 4.2 and Appendix H of the *Process Areas (OU-3) Vadose Zone and Groundwater Characterization Work Plan - Revision 1* (Vadose Zone Work Plan) dated August 20, 2010. A chronology of subsequent communications between EPA and ARC regarding the OU-3 sub-surface utility and dry well investigation is provided below. Section 4.2 and Appendix H of the Vadose Zone Work Plan, and associated communications, are provided as Attachment A (PDF).

- September 3, 2010: CH2M Hill provided BC with a historical map identifying fast fuel locations south of Burch Drive, and requested investigation of an unknown pipeline at the southeast side of the W-3 Dump Leach Surge Pond and two gas valves located between the Precipitation Plant and Lead Shop. This map is provided in Attachment A.
- September 13, 2010: EPA provided ARC comments on Section 4.2 and Appendix H of the Vadose Zone Work Plan via a technical memorandum prepared by CH2M Hill on September 10, 2010 (provided in Attachment A). EPA provided ARC with approval to proceed with the investigation on the condition that eight issues outlined in the technical memorandum were resolved (paraphrased):

    1) Follow specified sequencing/scheduling and investigate above ground features including those identified in the September 3, 2010 correspondence;
    2) Notify EPA 5 days prior to starting work;
    3) Provide quality assurance/quality control (QA/QC) procedures in the format specified;
    4) Process equipment through an equipment check area prior to use;
    5) Specify grid layouts/transect spacing;
    6) Investigate anomalies by intrusive methods;
    7) Investigate additional features beyond those listed in the Vadose Zone Work Plan; and
    8) Investigate features that extend beyond the Process Areas boundary.

- September 17, 2010: ARC generally agreed with the conditions specified in the CH2M Hill technical memorandum dated September 10, 2010, except that ARC preferred to provide its own version of QA/QC procedures and that ARC could not guarantee the EPA schedule would be met due to potential schedule conflicts and safety concerns associated with the removal actions.
- September 22-23, 2010: BC provided EPA with *QA/QC Procedures for Geophysical Investigation* prepared by Spectrum Geophysics (Spectrum) on September 20, 2010 (provided electronically in Attachment A). EPA responded that the submittal was acceptable.
- September 27 and 29, 2010: EPA requested confirmation from ARC on five of the eight issues from the CH2M Hill technical memorandum dated September 10, 2010. ARC responded that they were in agreement with and confirmed EPA's comments.

- October 4, 2010: ARC began the Process Areas sub-surface utility and dry well investigation, but heavy rains limited progress until October 6, 2010. CH2M Hill provided concerns verbally about the investigation approach.
- October 7, 2010: EPA, ARC, CH2M Hill, and BC held a teleconference to discuss the approach of the investigation. In e-mail correspondence following the teleconference, EPA requested ARC provide the following additional information:

    1) Schedule of activities;
    2) Description of the daylighting event; and
    3) Rationale behind the sequencing of events.

Section 2 of this Technical Memorandum provides background information regarding utility pipelines, conveyance features, and suspected dry wells. Section 3 describes the approach for investigating the sub-surface utilities and suspected dry wells. Sections 4 and 5 describe the sequencing of events and schedule of activities.

2. Background Information

This section summarizes background information regarding utility pipelines, conveyance features, and suspected dry wells in the Process Areas. The information is based on reviewing Site records, conducting Site reconnaissance, and conducting an intrusive investigation in 2004. There are several key Site records in the historical files maintained by EPA (listed below and included electronically in Attachment A) that identify relevant features.

- 1954 Metallurgical Plant Plan: this is a faded and degraded Anaconda 1-inch to 50-ft scale map, possibly an original, which indicates revisions in 1954, 1955, and 1959. It identifies water/fire supply and sewer utilities, manholes and hydrants, sulfuric acid lines, ditches, drains, and many other conveyances in the northern half of the Process Areas. It shows the general layout for the Acid Plant and the Sulfide Plant.
- Administration and Support Area Maps: these two undated maps are photocopies and the print is extremely light. They identify water/sprinkler/fire supply and sewer utilities, manholes, air and fuel lines, drains, and a dry well near the Assay Laboratory.
- 1972 Process Flowsheets: C.W. Kelley prepared three diagrams that illustrate the primary/secondary crushing circuits, Acid Plant/Precipitation Plant circuits, and the Sulfide Plant circuit. It identifies fluid flow rates and concentrations of acid copper at various stages of the mining process. There is a fourth undated diagram that illustrates the Precipitation Plant circuit and also identifies flow rates and concentrations.

2.1 Utility Pipelines and Solution Conveyance Features

Process and utility pipelines, drains, and ditches were formerly used in the Process Areas for conveying chemicals, process solutions, and wastes. Types of solutions that were conveyed can be subdivided into the following categories:

- Pregnant Solution – solution that was metal rich after leaching ore (either in vats or in heaps);
- Spent Solution – solution that had the copper removed before reuse or disposal to the waste ponds;
- Acid – sulfuric acid of varying concentration produced in the Acid Plant for leaching metals from ore;
- Fuel – gasoline and diesel fuel for mine vehicles;
- Drain – process wastes (e.g., wastewater, oil, grease, sludge, spent chemicals) from floor drains, sumps, or other process feature sources; and
- Sewer – wastewater from bathrooms, sinks, or other non-process waste points.

Process and waste solutions were transferred from point-of-origin to point-of-use to point-of-disposal by a variety of methods, including:

- Above ground piping;
- Piping in concrete trenches at ground level;
- Underground (i.e., buried) piping; and
- Gravity flow surface ditches (both lined and unlined).

The construction and condition of sub-surface pipelines and suspected dry wells that may have been used to convey ore beneficiation solutions and waste streams, or dispose of waste streams, are generally known, with some uncertainties associated with the following:

1) Some original Anaconda mining pipelines have been modified, removed, or covered by subsequent Site operations (e.g., the majority of pipelines associated with the former Anaconda Acid Plant were covered by the Arimetco Phase III Heap Leach Pad and Mega Pond);
2) Some pipelines are indicated on historical Anaconda engineering drawings, but may not have been constructed as designed;
3) Historical maps and engineering drawings are not available for some utilities and suspected dry wells although they have been inferred from historical Site photographs or Site reconnaissance; and
4) Some pipelines have been identified during recent Site reconnaissance, but are not indicated on historical drawings.

    - Two north-south trending steel pipes daylighting adjacent to and about 10 feet inside the trench between the Leach Vats and Solution Tanks
    - One east-west trending steel pipe daylighting behind the Truck Wash and Paint Shop
    - Various transite pipes broken and daylighting in the Sulfide Plant area
    - Steel pipe daylighting on the north end of the wash water solution storage tanks
    - One 4-inch steel pipe daylighting perpendicular to the Concrete Ramps located north of the W-3 Dump Leach Surge Pond
    - A pump structure and associated pipes in a low area northeast of the Concrete Ramps

It is recognized that some continued uncertainty remains due to the potential for other undiscovered/undocumented utility pipelines to be encountered. Excluding recently identified conveyance features and those that may be identified during future phases of work, utility pipelines and solution conveyance features are listed in Table 1 and shown on Figure 2-2 (reproduced from the Vadose Zone Work Plan).

Table 1. Utility Pipelines and Solution Conveyance Features

ID	Feature	Category	Description
UT-A	Vat Leach Pregnant Solution	Pregnant Solution	12-inch Transite Pipe in Concrete Trench
UT-B	W-3 Dump Leach Pregnant Solution	Pregnant Solution	Above ground 12-inch Transite Pipe
UT-C	Sulfide Concentrate Slurry	Pregnant Solution	Unknown Piping
UT-D	Precipitation Plant Spent Solution to Pond	Spent Solution	Underground Piping and Unlined Trench
UT-E	Precipitation Plant Spent Solution to Acid Plant	Spent Solution	8-inch Wooden Piping in Concrete Trench
UT-F	Sulfide Tails Slurry, North	Spent Solution	Above/Underground 12-inch Transite Pipe
UT-G	Strong Sulfuric Acid to Vat Leach	Acid	12-inch Transite Pipe in Concrete Trench
UT-H	Sulfuric Acid to W-3 Dump Leach	Acid	Above/Underground 12-inch Transite Pipe
UT-I	Acid Line	Acid	Above/Underground 4-inch Metal Pipe
UT-J	Fuel Distribution Pipeline	Fuel	Underground 2-inch Metal Pipe
UT-K	Truck Wash Sump Drain	Drain	Underground 18-inch Metal Pipe
UT-L	Grease Pit Drain	Drain	Underground Pipe
UT-M	Fuel Tank Sump Drain	Drain	Underground Pipe
UT-N	Assay Lab Drain	Drain	Underground 6-inch Pipe
UT-O	Secondary Crusher Dust Slurry Drain	Drain	Underground 8-inch Metal Pipe
UT-P	Vat Leach Pumphouse Drain	Drain	Underground 1-inch Metal Pipe
UT-Q	Sulfide Pumphouse Overflow Ditch	Drain	Unlined Ditch
UT-R	Administration Sewer	Sewer	Underground 8-inch Metal Pipe
UT-S	Acid Plant Sewer	Sewer	Underground Pipe
UT-T	Leach Plant Sewer	Sewer	Underground Pipe
UT-U	Main Line Sewer	Sewer	Underground 24-inch Concrete Pipe
UT-V	Weed Heights Sewer	Sewer	Underground Pipe
UT-W	Sulfide Tails Slurry, South	Spent Solution	Above ground 12-inch Transite Pipe
EEE	Overflow Solution Ditch	Drain	Unlined Ditch
FFF	East Solution Ditch	Drain	Unlined Ditch
WW	Calcine Ditch	Spent Solution	Unlined Ditch

2.1.1 Pregnant Solution Conveyances

Pregnant (i.e., metal-bearing) ore beneficiation solutions were typically transported in contained pipelines laid on the surface or in concrete trenches in order to minimize the loss of valuable metal content. Three pregnant process solution pipelines have been identified: Leach Vat, W-3 Dump Leach, and Sulfide Concentrate Slurry.

- Leach Vat Pregnant Solution (UT-A): Pregnant solution from the Leach Vats was transferred to the Solution Tanks and then to the Precipitation Plant by a 12-inch transite pipe located in the concrete trench which is at ground level and under the roadway between the Leach Vats and the Precipitation Plant. The pipe was accessible for observation and repair by removing the trench cover plates, and any spillage was collected either in the Overflow Sump located southwest of the Solution Tanks or in the dry well located where the trench connects with the Precipitation Plant. Flow sheets (Kelley, 1972) indicate that this pipe conveyed about 700 gallons per minute (gpm) of pregnant solution containing approximate concentrations of 20 grams per liter (g/L) copper, 6 g/L acid, and 7 g/L iron.
- W-3 Dump Leach Pregnant Solution (UT-B): Low grade ore was stockpiled on a liner on the south side of Burch Drive and leached in place with sulfuric acid solution. The pregnant solution was collected on a liner underlying the ore and was transferred to the Precipitation Plant via a 12-inch transite pipe primarily on the ground surface. W-3 Dump Leach solution was stored in the W-3 Dump Leach Surge Pond and then transferred to the Precipitation Plant by an underground pipeline around the northwest end of the tanks where it was processed separately from the leach vat solution. The aboveground portions of UT-B were removed in fourth quarter (4Q) 2010. Flow sheets (Kelley, 1972) indicate that this pipe conveyed about 800 gpm of pregnant solution containing approximate concentrations of 2 g/L copper, and 3 g/L acid.
- Sulfide Concentrate Slurry (UT-C): Sulfide concentrates were piped from the floatation cells to various thickeners and settling tanks. Uncertainty exists as to the construction materials and position relative to ground surface for this conveyance, as no evidence exists of the pipes and most of the Sulfide Plant has been dismantled.

2.1.2 Spent Solution Conveyances

Spent ore beneficiation solutions were transported in above ground pipelines, underground pipelines, and surface ditches. The chemistry and makeup of the spent solutions were likely to have been highly variable depending on the source of the waste. Spent solutions often contained solids slurried in the solutions. Five spent process solution pipelines have been identified: Precipitation Plant to Pond and to Acid Plant, Sulfide Tails Slurry North and South, and Calcine Ditch.

- Precipitation Plant Spent Solution to Pond (UT-D): Spent solutions consisted of iron sulfate solution and wash water generated during precipitation of the copper. The spent solution was re-circulated and stored in the Spent Solution Sump located at the northwest end of the Precipitation Plant. From the Precipitation Plant, it was piped directly to the Evaporation Ponds or to theW-3 Dump Leach Surge Pond. According to a Site historical map, the spent solution exited the sump through underground piping, discharged into an open ditch for approximately 100 feet, and then re-entered an underground pipe that appears to have discharged to the north end of the Calcine Ditch. Flow sheets (Kelley, 1972) indicate that this pipe conveyed about 700 gpm of spent solution containing approximate concentrations of 0.5 g/L copper, 2 g/L acid, and 28 g/L iron.
- Precipitation Plant Spent Solution to Acid Plant (UT-E): The primary disposal method for the Precipitation Plant spent solutions was to convey these solutions approximately 1,400 feet to the Acid Plant for use in slurrying calcines. Spent solutions from the Precipitation Plant were conveyed via piping located in the concrete trench between the Leach Vats and the Precipitation Plant (pipe materials are assumed to have consisted of an 8-inch diameter wooden stave pipe (Douglas fir). Flow sheets (Kelley, 1972) indicate that this pipe conveyed about 400 gpm of spent solution containing approximate concentrations of 0.5 g/L copper, 2 g/L acid, and 28 g/L iron.

- Sulfide Tails Slurry, North (UT-F): Waste solutions from the Sulfide Plant exited the plant at several points in underground and above ground 12-inch diameter transite pipes. The pipes carried the wastes to the Sulfide Tailings as a slurry. The aboveground portions of UT-F were removed in 4Q 2010.
- Sulfide Tails Slurry, South (UT-W): A second Sulfide Tails Slurry line was installed which exited the Sulfide Plant and paralleled the W-3 Dump Leach Pregnant Solution pipeline for approximately 1,000 feet. The pipeline continued to the top of the Sulfide Tailings embankment where it discharged waste solutions to the tailings pond in several places. The Sulfide Tails Slurry Line was constructed of 12-inch diameter transite pipe and was laid on the ground surface. The aboveground portions of UT-W were removed in 4Q 2010.
- Calcine Ditch (WW): The Calcine Ditch was an unlined surface ditch which was used to convey the calcine solid waste from the Acid Plant slurried with the Spent Solution from the Precipitation Plant to the Evaporation Ponds.

2.1.3 Acid Lines

Sulfuric acid was distributed to leaching components in 12-inch diameter transite pipes. Strong acid pipelines were located in the concrete trench at ground surface. Weak acid appears to have been conveyed in underground and above ground pipelines. Three acid pipelines have been identified: Strong Sulfuric Acid to Vat Leach, Sulfuric Acid to W-3 Dump Leach, and Acid Line.

- Strong Sulfuric Acid to Vat Leach (UT-G): Sulfuric acid (93 percent concentration) was distributed from the Acid Plant to the Vat leach Tanks in a 12-inch diameter transite pipe located in the main concrete trench.
- Sulfuric Acid to W-3 Dump Leach (UT-H): Sulfuric acid was also piped to the W-3 Dump Leach located south of Burch Drive in underground and above ground 12-inch diameter transite pipes. The piping was primarily above ground and parallels the return piping of pregnant leach solutions from the W-3 Dump Leach (the piping was underground for about 1,000 feet from the Precipitation Plant to the approximate location of the former Tire Pile). The aboveground portions of UT-H were removed in 4Q 2010.
- Acid Line (UT-I): A small 4-inch diameter metal line is labeled on the 1954 Metallurgical Plant Plan as an acid line just east of the Precipitation Plant drying beds. It is unclear how, or if, this line is connected to the main acid distribution lines, and the pipe size and material suggest a use other than acid conveyance. Portions of this line are visible as it exits the W-3 Dump Leach Surge Pond near the pier structure, runs parallel to UT-W, heads diagonally south above and below ground towards the south, bends to the south perpendicular towards the Precipitation Plant, and runs adjacent to the southern edge of the concrete apron near the drying beds. Near the Precipitation Plant, the acid line is 18 inches below grade in a small concrete trench at ground level.

2.1.4 Fuel Lines

A Fuel Distribution Network (UT-J) conveyed gasoline and diesel fuel for mine vehicles. Three sets of underground piping in the network were used for the transfer of various fuel mixtures from the above ground storage tanks to three nearby fuel pumps. The first set consists of two 2-inch diameter metal lines that connect the above ground storage tanks to the pump shed associated with Filling Station #2, which is 30 feet to the northwest. The second set consists of two 2.5-inch diameter metal lines that connect the above ground storage tanks to the pump shed associated with Filling Station #3, which is 40 feet to the southwest. The third set consists of two 2-inch diameter metal lines that connect the above ground storage tanks to the concrete pad and former pumps associated with Filling Station #4, which is 200 feet to the southwest.

2.1.5 Drain Lines and Ditches

Nine drain features (i.e., underground pipelines and surface ditches that were gravity drained from floor drains and sumps) have been identified. These features did not originate from plant process tanks, but from ancillary support locations such as the Truck Shop. Drain lines likely conveyed much smaller volumes than process solution pipelines.

- Truck Wash Sump Drain (UT-K): A small 2-foot by 2-foot concrete sump box is located on the north side of the concrete wash pad associated with the Truck Wash and Paint Shop. An 18-inch diameter metal drain line exits the sump and drains underground about 50 feet to the Upper Truck Sludge Pond. Wash water from vehicle or equipment washing ran off through the drain line to the pond area.
- Grease Pit Drain (UT-L): The undated Administration and Support Areas map shows a drain line, identified as the “6-inch Grease Pit Drain”, exiting the Truck Shop traveling towards the northeast. The line appears to drain to the Lower Truck Sludge Pond, but connection to the pond is inferred because there is no map coverage of the area to confirm this.
- Fuel Tank Sump Drain (UT-M): The undated Administration and Support Areas map indicates a 6-inch diameter drain line exiting from the Filling Station #3 concrete pad and leading to the northeast. It is assumed that this drained from a collection sump similar to the wash pad sump associated with the Truck Wash and Paint Shop. Final disposition of the drain line is not known.
- Assay Laboratory Drain (UT-N): The undated Administration and Support Areas map shows a 6-inch diameter laboratory drain line exiting the southeast corner of the Assay Laboratory to a dry well (Dry Well #3) located approximately 100 feet in line with the end of the Large Warehouse Annex building. It is possible that laboratory wastes were disposed in this drain line.
- Secondary Crusher Dust Slurry Drain (UT-O): Water was sprayed onto the crushed ore at the Secondary Crusher for agglomeration and dust control. The source and quality of the water is not known and may have been fresh well water or recycled water from other parts of the process, such as wash water from leaching or precipitation. Excess runoff was collected in a sump and conveyed in an underground 8-inch diameter metal pipe until it exited to the Sulfide Tailings.
- Vat Leach Pumphouse Drain (UT-P): Anaconda engineering drawings (YC-11 and YC-35) indicate a drain line exiting from the Solution Advance Pumphouse, previously located between the Sulfide Ore Crusher/Stockpile and the northwest end of Leach Vat No. 8, to an unidentified dry well (Dry Well #1). The drawings indicate a 1-inch diameter metal drain line between the Solution Advance Pumphouse and Leach Vat #8. The pumphouse has been removed and no evidence of the drain has been found. The drain line likely was used to collect and dispose of floor spillage from leach vat solutions including pregnant and wash solutions.
- Sulfide Pumphouse Overflow Ditch (UT-Q): A third Solution Ditch was identified at the north end of the Process Areas, north of the Sulfide Plant, by the BLM through examination of old aerial photos. This was likely to have been an overflow ditch from the Sulfide Pumphouse. Ground surface examination did not locate any remaining surface expression of this ditch.
- Overflow Solution Ditch (FFF): The Overflow Ditch is an unlined surface ditch with occasional culverts where it passes under roads. The ditch is visible on historical photographs carrying solutions from the Overflow Sump around the northwest end of the Solution Tanks for disposal in the sulfide tailings ponds.

- East Solution Ditch (EEE): This ditch was likely used to convey stormwater or other runoff solutions that collected at the Lower Truck Sludge Pond to the Calcine Ditch. The 1954 Metallurgical Plant Plan labels this feature as the "garage waste and spent solution ditch".

2.1.6 Sewer Lines

Sewer lines collected the wastewater from toilets and sinks in ancillary support buildings in the Process Areas. Sewer lines were underground and typically constructed of 8-inch diameter metal pipe for laterals and 10- to 24-inch diameter concrete pipe for main lines. The sewer lines were connected to one system which drained to the Sewage Solids Tank located at the north end of the Process Areas. Solids were settled in this tank and waste water was transferred to the north. Currently, wastewater from this tank is conveyed to the Weed Heights Sewage Lagoons located at the southwest corner of the Lined Evaporation Pond. Five sewer lines have been identified: Administration, Acid Plant, Leach Plant, Main Line, and Weed Heights.

- Administration Sewer (UT-R): Several 8-inch diameter metal pipes, typically 8 to 10 feet bgs, collect waste water from building bathrooms kitchens and sinks. Buildings serviced on this line include: Administrative Building, Change House, School House, Assay Lab, Truck Shop, Electrical Shop, and Primary Crusher.
- Acid Plant Sewer (UT-S): Buildings serviced on this line include: Acid Plant, Leach Vats, Secondary Crusher, and Carpenter's Shop.
- Leach Plant Sewer (UT-T): Buildings serviced on this line include: Solution Tanks Pumphouse and Sulfide Plant Foreman's Office.
- Main Line Sewer (UT-U): The Main Sewer Line connects the upstream points to the Sewage Solids Tank.
- Weed Heights Sewer (UT-V): Buildings serviced on this line include: Weed Heights residential and community buildings, and the Sulfide Plant. This line drains directly to the Sewage Solids Tank.

2.2 Suspected Dry Wells

There are five suspected dry wells in the Process Areas based on Site records and a field reconnaissance. The anticipated locations of the dry wells are shown on Figure 3-3 (reproduced from the Vadose Zone Work Plan). Additional background information is provided in a technical memorandum entitled *Drywells, Sumps and Source Areas Located within the Historic Anaconda Yerington Mine Site Process Areas Operable Unit (OU-3)* prepared by CH2M Hill on May 7, 2010 (provided in Attachment A).

- Dry Well #1: Historic Site maps indicate a drain line (UT-P) exiting from the Solution Advance Pumphouse, previously located between the Sulfide Ore Crusher/Stockpile and the northwest end of Leach Vat No. 8, to an unidentified dry well. Anaconda engineering drawings (YC-11 and YC-35) indicate the drain runs to a dry well in a "suitable location". The drawings do not provide the location or construction details of the dry well. The pumphouse has been removed and no evidence of the drain line or dry well has been found. The dry well may have received pregnant solution and wash solution.
- Dry Well #2: A historical map entitled "Administrative Support Areas" indicates a drain line (UT-M) exiting from the Filling Station #3 concrete pad and leading to the northeast. It is possible that the line terminates in a dry well.

- Dry Well #3: A historical Site map shows a laboratory drain line (UT-N) exiting the southeast corner of the Assay Laboratory to a dry well located approximately 100 feet in line with the end of the Large Warehouse Annex building. A historical map entitled "Administrative Support Areas" indicates a dry well that measures 10 feet by 10 feet and is approximately 4 feet below grade. The map does not provide the construction details of the dry well. The dry well may have received laboratory wastes.
- Dry Well #4: Although not located on historical maps, a dry well is suspected to be located near the former cooling tower located northwest of the Solution Tanks. The source of the information for this dry well is based on comments provided by a former EPA RPM 9 regarding the *Draft Process Areas (OU-3) Remedial Investigation Workplan* dated August 30, 2007.
- Dry Well #5: Historical Site maps indicate a dry well at the junction of the concrete trench containing the Leach Vat Pregnant Solution line and the influent to the Precipitation Plant. Since the dry well is located near the lowest portion of the concrete trench, any spillage that occurred in the concrete trench likely drained to the dry well. Anaconda engineering drawings (YD-12 and YD-49) indicate a rock-filled dry well measuring 3.5 feet wide by 5 feet long by 5 feet deep located at the bottom of the concrete trench. The dry well may have received pregnant solution, spent solution, and strong acid.

2.3 Previous Investigations

Sub-surface utilities were investigated in 2004 pursuant to the *Process Areas Work Plan* dated December 15, 2003. The results of the investigation were presented in the *Data Summary Report for Process Areas Soils Characterization* (Soils DSR) dated November 1, 2005. Selected portions of these documents are provided electronically in Attachment A. Locations of sub-surface utilities were identified by reviewing Site records. The various alignments of these features were compiled and 65 suspected locations of pipe terminations and junctions were identified. Initially, a private utility locating service was engaged to try to locate, by surface survey, as many pipelines as possible. It was soon apparent that a majority of the lines were constructed of non-conducting materials that were not detected by the survey equipment. A backhoe was then used to excavate at each of the 65 suspected locations ranging in depth from 1 to 12 feet below grade to determine if a pipe was present and what its condition and construction might have been. Photographs of the excavations were included as Appendix B1 of the Data Summary Report and are provided electronically in Attachment A.

When a pipe was located, the excavation would continue along the pipe until a connecting joint was located, at which point a soil sample was typically collected from 6 to 12 inches directly beneath the bottom of the pipe. A total of 60 samples were collected at locations PA-UT1 through PA-UT60 shown on Figure 2-3 (reproduced from the Soils DSR). The samples were analyzed for metals, radiochemicals, volatile and semi-volatile organic compounds, total petroleum hydrocarbons (TPH), polychlorinated biphenyls, pesticides, herbicides, and acid-base potential. Analytical results for all collected samples were below preliminary screening criteria except for the following samples and analytes: PA-UT29 exceeded criteria for radium-226 and thorium-232; PA-UT23 exceeded criteria for 1,2,4- and 1,3,5-trimethylbenzene; and 15 samples exceeded criteria for various TPH ranges.

3. Investigative Approach

Although many utilities were located by potholing with a backhoe in 2004, the objective of the proposed investigation in 2010 is to use a variety of geophysical survey techniques to attempt to locate identified and unknown sub-surface utilities and suspected dry wells. Anomalies detected from the survey will then be explored by intrusive methods. The information from this investigation will provide the basis for additional soil sampling associated with these features as part of a subsequent phase of the Process Areas Remedial Investigation (RI). In addition, the information will assist with the placement of characterization boreholes proposed in the Vadose Zone Work Plan.

3.1 Geophysical Survey

Spectrum will conduct a comprehensive geophysical survey of the sub-surface utility lines and suspected dry wells. The objectives of the sub-surface investigation as presented in Section 4.2 of the Vadose Zone Work Plan are to:

1) Locate detectable dry wells within a 200-foot radius of the five locations identified by CH2M Hill;
2) Determine the geometry of identified underground utilities; and
3) Assess the condition of camera-accessible sub-surface utility lines.

As presented in Appendix H of the Vadose Zone Work Plan, the following equipment will be used to locate detectable metallic and non-metallic structures:

- Geonics EM-61 high sensitivity metal detection;
- Geonics EM-31 terrain conductivity meter;
- Sensors and Software ground penetrating radar (GPR) unit;
- RD electromagnetic utility locating transmitter with matched receiver;
- Fisher TW-6 M-scope shallow focus metal detector;
- Microtransmitter (sonde) attached to fiberglass probes; and
- Camera capable of being inserted into accessible pipelines.

The EM-31/-61 and GPR equipment will be used when a targeted utility line/dry well does not daylight and to search for unknown sub-surface utility lines in a targeted area (e.g., gas valves/piping identified by the EPA in the area south of the Precipitation Plant). If a metallic line daylights, the RD electromagnetic utility locating transmitter will be attached to the pipe end and the matched receiver will be used to trace the line. The M-scope shallow focus metal detector will also be used to augment the investigation of metallic lines or to locate a suspected metallic sub-surface structure (e.g., buried manhole lid). For non-metallic piping, cleanouts, and drains that daylight and are unobstructed (e.g., not collapsed or filled with sediment), the sonde will be inserted to trace the line and the camera will be inserted to assess the condition of the pipe. The sonde can also be used augment the investigation of metallic lines, if needed. Daylighting refers both to pipes that are accessible from the surface or from a sub-surface structure such as a sump or manhole.

The equipment will be processed daily through a background area check and an equipment check area (also referred to as a "prove out area") as described in the QA/QC Procedures dated September 20, 2010 (Attachment A). Detected features will be surveyed with a GPS unit to update project CADD files and the utility map for the Process Areas. Anomalies detected from the survey will then be explored by intrusive methods described in Section 3.2.

3.1.1 Sub-Surface Utilities

Sub-surface utilities to be investigated are shown on Figure 4-1 which has been revised from the Vadose Zone Work Plan to show labels, the Weed Heights Sewer Line (UT-V), suspected gas valves south of the Precipitation Plant, and a non-designated pipeline at the southeast side of the W-3 Dump Leach Surge Pond. Figure 4-1 shows a sub-set (i.e., only sub-surface utility features) of the utility pipelines and solution conveyance features shown on Figure 2-2 (reproduced from the Vadose Zone Work Plan). Additional features (beyond those already known and listed in the Vadose Zone Work Plan), if discovered, will also be evaluated. Conveyance features that extend beyond the sub-set area specified in Figure 4-1 within the Process Areas will be completely investigated during the geophysical survey work. The investigation is intended to fully investigate the lateral extent of detectable sub-surface conveyance lines within the Process Areas, and any sub-surface conveyances that extend beyond the boundaries of the Process Areas.

Passive and active electromagnetic utility locating methods will be used in an effort to identify metallic piping. In non-metallic piping, cleanouts and drains that are accessible, a microtransmitter (sonde) attached to fiberglass probes will be inserted into openings and the transmitted signal from the sonde will be identified on the ground surface using a hand held receiver. The length of probe inserted into the pipe depends on the diameter, condition and construction of the pipe. Typically access is required every 100 to 250 feet along the piping. In addition, a camera will be inserted into accessible pipelines to determine the construction and general condition of the utility lines. Where possible, manhole covers will be opened to inspect the construction and condition of pipelines.

3.1.2 Suspected Dry Wells

Suspected dry wells to be investigated are shown on Figure 3-3 (reproduced from the Vadose Zone Work Plan). Emphasis will be placed on conducting the investigation from the point of discharge (e.g., the laboratory building drain or fueling pad drain), along the discharge pipeline or drain, and towards the location of the suspected dry well. An attempt will be made to trace the line if it is metallic. Intrusive methods may be used to complement this approach. If this first approach is unsuccessful, then the approximate locations of the dry wells will be staked in the field.

ARC anticipates that the staking will be performed with oversight from an EPA representative or contractor. A 200-foot radius (an approximate 3-acre area) around each staked location will then be investigated using high sensitivity metal detection (EM-61), terrain conductivity (EM-31), and GPR in an effort to delineate the location of each well. If the dry well cannot be located within the 200-foot radius and it is evident that the discharge pipeline or drain continues on, then the survey will continue outside of the initial search radius. The specific approach for each dry well is provided below.

- Dry Well #1: The investigation will initially focus on locating the foundation of the Solution Advance Pumphouse with intrusive methods. If the foundation is located, the perimeter will be inspected for a drain line. If the line is located, an attempt will be made to trace the line. If this initial approach is unsuccessful, a stake will be placed approximately 20 feet from the northwest end of Leach Vat No. 8. The geophysical survey will then be conducted in a 200-foot radius from this point which spans the edge of the Phase III Heap Leach Pad to the Sulfide Ore Crusher/Stockpile to across the road near the Sulfide Plant.

- Dry Well #2: A drain grate was discovered on the Filling Station #3 concrete pad which may provide an opportunity to trace the drain line if it is metallic. The investigation will begin at this grate and proceed along the drain line. The geophysical survey area will be focused on the linear feature as opposed to placing a stake and creating a search radius. Intrusive exploration will likely be the fastest and most effective technique for this location. The drain line will be explored until it can be determined where it terminates.
- Dry Well #3: The investigation will begin at the southeast corner of the Assay Laboratory where the 6-inch diameter drain line visibly exits the building. An attempt will be made to trace the line, but Site reconnaissance indicates it may be non-metallic (possibly clay). If this fails, then a stake will be placed approximately 100 feet from the Assay Laboratory in line with the end of the Large Warehouse Annex building. The geophysical survey will then be conducted in a 200-foot radius from this point which spans the main thoroughfare. Transects will be oriented plant north/south which is perpendicular to the drain line which likely runs plant east/west.
- Dry Well #4: Since this feature is not located on historical maps, a stake will be placed just north of the former cooling tower foundation located northwest of the Solution Tanks. The geophysical survey will then be conducted in a 200-foot radius from this point which spans the entire graded bench.
- Dry Well #5: Based on Site reconnaissance, the dry well is not visible and there is considerable metallic structures and scrap which will interfere with most geophysical techniques. The dry well is adjacent to the former radiological control area (RCA). An attempt will be made to uncover the top surface of the dry well for inspection. A meeting between CH2M Hill and ARC is suggested to further discuss the specific approach for this dry well.

3.2 Intrusive Exploration

ARC plans to review the processed geophysical survey data with EPA prior to conducting intrusive exploration activities. Pending the results of the geophysical surveys, EPA and ARC will select locations for intrusive exploration to be conducted with a combination of a shovel, hand auger, and backhoe. A shovel will be used to expose near surface utilities (6 to 12 inches below grade). A hand auger will be used to confirm the presence of deeper utilities (greater than 12 inches below grade) and refine the location for mechanized excavation. The backhoe will be used to expose the top portion of a dry well or utility line termination (i.e., "daylighting"). The construction details and condition of the investigated feature will be recorded, a photograph of the feature will be taken, and the location will be determined by GPS. If appropriate, the excavation will be backfilled and compacted as necessary upon completion of the investigation. The results of the intrusive exploration will be used to update the geographic information system (GIS) for the Site and utilities map for the Process Areas.

3.3 Surface Survey

EPA requested that the remaining features (i.e., the above ground utility pipelines and solution conveyance features) shown on Figure 2-2 (reproduced from the Vadose Zone Work Plan) be investigated as well. Most of these features are currently present and visible. However, some of these are missing or inaccessible (e.g., utilities associated with the former Acid Plant) and their locations cannot be verified by geophysics. A Site reconnaissance will be conducted of the above ground utility pipelines and solution conveyance features that involve the following tasks:

1) Taking photographs of the feature;
2) Locating major pipeline/conveyance junctions and terminations with a GPS; and
3) Recording construction details and condition of the feature.

The results of the surface survey will be used to update the GIS for the Site and utilities map for the Process Areas.

4. Sequencing of Events

A phased approach and sequencing of events was discussed with the EPA for the sub-surface utility and dry well investigations. Initially, Spectrum initiated dry well surveys at two locations anticipated to produce positive results (i.e., easily identified dry wells) to develop Site-specific experience for these features. After the two locations were investigated, Spectrum switched to the underground utility surveys pursuant to EPA direction.

- Phase I: Includes geophysical surveys of the sub-surface utilities and features identified in Figure 4-1 (revised from the Vadose Zone Work Plan), including features identified by CH2M Hill in correspondence dated September 3, 2010. Previously unmapped or unknown features identified by geophysical methods will be investigated. Phase I includes assessing the condition of camera-accessible sub-surface utility lines. Phase I also includes geophysical surveys of the five suspected dry well locations shown on Figure 3-3 (reproduced from the Vadose Zone Work Plan). Phase I will conclude with intrusive exploration in areas where an anomaly is indicated based on the geophysical survey data. To prevent simultaneous work conflicts with removal actions in the Process Areas, the sequence of survey activities may be modified. In addition, Spectrum will perform the surveys during separate mobilizations.
- Phase II: The second phase will map the remaining features (i.e., the above ground utility pipelines and solution conveyances) shown on Figure 2-2 (reproduced from the Vadose Zone Work Plan). In addition, Phase II activities will include:

  - Geophysical investigation of any additional utility locations or anomalies identified during Phase I investigations, but not specified/identified on Figure 4-1;
  - Geophysical investigation of any additional utility locations or anomalies identified during Phase II investigations, but not specified/identified on Figure 2-2;
  - Geophysical investigation of all identified utility locations to their terminus points; and
  - Intrusive investigation of terminus points (including sumps and dry wells) identified during Phase I or II investigations to confirm past use and configuration.

5. Schedule of Activities

The schedule of geophysical surveys will be coordinated with 2010 removal action activities in the Process Areas during 4Q 2010. As of December 17, 2010, Spectrum has completed the following activities:

- All EM-31 and EM-61 data collection and utility locating for all five dry wells;
- Utility locating, EM-31 and EM-61 data acquisition along the north, west, and south sides of the Precipitation Plant area as far as level ground will allow;
- Utility investigation for accessible sewer, water/fire, and discharge piping; and
- Video investigation of accessible utilities (using conventional techniques for pipes with little blockage).

Spectrum anticipates a report of findings for the utilities and dry well investigation to be available the second or third week of January, 2011. The following describes the geophysical surveys completed through their fourth mobilization:

- Phase I, Shift 1: Spectrum mobilized to the Site on October 4, 2010 and received Site-specific Health and Safety training. Heavy rainfall limited field progress until October 6, 2010. The first shift was completed on October 13, 2010. EPA-approved QA/QC procedures were followed on a daily basis. The following provides a summary of the activities conducted during the first shift.

  - October 4: Initiated QA/QC procedures on a known pipeline located between the fuel storage tank area, east side of the Warehouse Building.
  - October 6: Completed QA/QC procedures. Performed EM-61 and EM-31 data collection in area of Dry Well #3 and UT-N. Collected data and processing for possible location of dry well in area. Small section of possible UT-N location parallel with crossing water line. Excavation for possible dry well not performed due to location within main access road for removal actions. Set up grid location for Dry Well #2, southeast of fueling station.
  - October 7: Performed EM-61 and EM-31 data collection in area of Dry Well #2 and UT-M. Collected data and processing for possible location of the dry well. Investigated the location of any utilities within the area of Dry Well #1 and UT-P. No utilities found to be in way of possible investigation. Area of possible excavation for northeast corner of the building foundation was pot holed with a hand auger. Six locations tested to depths of 4 feet, but there was no indication of the foundation. The excavation of UT-M leading to Dry Well #2 discovered a 4-inch cement pipe running out of southeast corner of the fueling pad. Fish tape was inserted to follow the pipe to the possible dry well location. After 40 feet, the cement pipe turned from a southerly to an easterly direction, and terminated into a 6-inch diameter metal pipe about 15 feet long. The metal pipe extension ended at the edge of the berm with no indication of a dry well.
  - October 8: GPS located UT-M from fueling pad and locations of discovered utility lines near area of Dry Well #3 and UT-N and area of Dry Well #2 and UT-M were also established with GPS. Spectrum moved to west side of the Precipitation Plant for the possible location of UT-H, UT-B, and UT-T, and set up area for scanning with locators EM-61, EM-31, and GPR. Collected data with EM-61 on the southwestern side of the Precipitation Plant starting with UT-A, and scanning south to the end of the structure.
  - October 9: Performed EM-31 and GPR data collection on the western side of, and adjacent to, the Precipitation Plant (an area of approximately 80 feet by 775 feet). A conductive line was identified based on a continuous pattern of resonant energy. Conducted EM-61 surveys on the north margin of, and adjacent to, the Precipitation Plant.

- October 10: Surveyed utilities in the area west of the Precipitation Plant. Investigation of UT-H running south from western side of Precipitation Plant. Pipe not found under the surface, but its location was found above ground to the southeast. Location of UT-B identified along the north side of the Precipitation Plant, which ran east to the discharge pond.
- October 11: With the objective to scan the area south of the Precipitation Plant, Spectrum set up a data collection grid using EM-61 and EM-31. The approximate location of UT-O was identified. The location of UT-H south of the Precipitation Plant was not discovered until this line daylighted to the southeast. Surveyed the southern area of the W-3 Dump Leach Surge Pond, and no buried pipes were identified using metal detection and GPR (see October 12 results). Surveyed previously mapped "unknown pipeline" on the north end of the W-3 Heap Leach Surge Pond, and determined that this pipe continued north.
- October 12: Surveyed existing sewer lines (UT-T/UT-S) and determined that these lines are difficult to locate from observed manholes using geophysics (i.e., best method is projection along observed manholes), likely due to an accumulation of sediment in the manholes. The approximate locations of UT-S and UT-R were partially confirmed. The investigation of the western locations of sewer lines was inconclusive. The resumed investigation of the pipe at the south end of the W-3 Dump Leach Surge Pond indicated a half-buried spigot of pipe (a buried piece of above ground pipe that terminated after 12 feet).
- October 13: Moved geophysics investigations to focus on the north area near the Sulfide Plant. Locations of underground pipelines UT-W, UT-F, and UT-C were investigated. Locations of spent solutions line UT-W and UT-F were partially located. Utility locations were mainly performed by investigating manholes found and using a charged sonde snaked up into lines in manholes. Spectrum also continued to collect GPS location of utilities that were found and also utilities reconfirmed on maps.

- Phase I, Shift 2: The second shift of Phase I was conducted from October 20 through 23, 2010.
  - October 20: Investigate sewer line UT-V with sonar frequency locator and M-scope. One manhole found on western side of Process Areas and sonar locator used to locate pipe to the east. Locating performed on western side of sewer line UT-T. Located middle manhole on side of road and inspected manhole for lines. Existing line to the north confirmed. Further attempts to locate discharge line UT-D were unsuccessful.
  - October 21: Locating performed on western side of sewer line UT-T and to the north toward the Foreman's Office. A line was detected and located up to building. Set up sonar locator for the western side of drain line UT-O. Ran sonar through the drain line to the west, but locating stopped in the middle of the access road below the Leach Vats. Performed locating on the western side of sewer line UT-R. Located the western-most manhole below the Plumber's Shop; noted two pipes exiting to the west and one to the east. The top pipe exiting to the west was located for about 150 ft until the line was obstructed. The lower pipe exiting to the west was blocked with debris. The pipe exiting to the east was previously located by Spectrum. Further Investigation of UT-S started at manhole on northeastern corner of Truck Shop. Efforts to explore locations of all six lines coming into manhole were inconclusive due to sediment blocking flow.

- October 22: Investigated acid line UT-H on southern end where pipe daylights. Used GPR to locate from the exposed pipe to about 150 ft north toward the Precipitation Plant until reception of the pipe became unclear. Re-explored location of line drain line UT-L. Still inconclusive that it exits where it is displayed on map. Returned to locate eastern side of sewer line UT-V from manhole found on lower end. Discovered next manhole to the west and found it to contain active sewer flows. Location further west was not possible since the manhole lid was rusted closed. Small sections of the lower western section of UT-V were discovered and located. Spectrum then collected GPS data on all of the newly discovered lines.

- Phase I, Shift 3: The third shift of Phase I was conducted from November 2 through 5, 2010.

  - November 2: Perform EM on area of Dry Well #1 near the north end of Leach Vat #8.
  - November 3: Perform EM on area of Dry Well #4 near north end of the Solution Tanks. Acid drain line UT-I was located visually by following it as it exits the W-3 Dump Leach Surge Pond near the pier structure, runs parallel to UT-W, then heads diagonally south above and below ground towards the south, then bends perpendicular to the south towards the Precipitation Plant, and adjacent to the southern edge of the concrete apron near the drying beds. A combination of hand digging and line tracing was used to locate underground portions of this 4-inch metal line.
  - November 4: Completed EM on Dry Well #4 and finished up with remaining portion of Dry Well #1. Removed the lid on the sewer manhole at junction of UT-U and UT-T near the northeastern corner of the Precipitation Plant. A sewer line at approximately 15 ft below grade runs southeast parallel to the Precipitation Plant as expected. GPR was used to locate manhole lids along this line to the southeast, but none could be detected. Removed the grate on sump on concrete apron near the northeast corner of the Truck Shop to determine what lines exit. Manually removed sediment from sump which was stained black, oily, and had a petroleum odor. There was no obvious bottom to the sump to a depth of about 3 ft below grade. Only one 10-inch line exited and locating efforts determined that it emptied to the Upper Truck Sludge Pond adjacent to drain line UT-K. Replaced the sediment and grate. Further investigated lines exiting from sewer manhole near the northeastern corner of the Truck Shop. It appears that drain line UT-L may originate from this manhole since locating efforts determined it ran to the apron of the Truck Wash and Paint Shop. It is uncertain if this line continues to the Lower Truck Sludge Pond. Performed an initial investigation of two previously unidentified features northeast of the W-3 Dump Leach Surge Pond: 1) a 4-inch steel pipe daylights perpendicular to the Concrete Ramps located just north of line UT-F/ditch FFF and appears to drain to the northeast; and a pump structure and associated pipes in a low area northeast of the Concrete Ramps. Additional investigation of these features will be conducted in Phase II.
  - November 5: Spectrum surveyed all identified utilities and boundaries of EM investigation using GPS. In addition, the remaining features (i.e., the above ground utility pipelines and solution conveyances) shown on Figure 2-2 (reproduced from the Vadose Zone Work Plan) were surveyed in by Brown and Caldwell using GPS (note this is a Phase II activity).

- <u>Phase I, Shift 4</u>: The fourth shift of Phase I was conducted on December 14 through 16, 2010 and focused on assessing the condition of camera-accessible sub-surface utility lines with conventional video equipment.
  - <u>December 14</u>: attempted to video sewer lines UT-S/-R from manhole at northeast corner of Truck Shop. Progress was limited to about 10 feet due to sludge in sewer lines and sediment in manhole. Completed video of UT-L for 150 feet; metal pipe was rusted, but in fair condition and fairly clear of sediment. Obstruction at 150 feet. Moved to UT-B and completed video of short pipe segment from pond to large weir box; pipe in good condition. Progress was limited to 40 feet from large weir box heading west due to sediment in pipe. Completed video of UT-D for 76 feet from smaller weir box at end of ditch to pipe heading north; further progress limited by sediment. Moved to concrete vault near northwest corner of Precipitation Plant. Segment of UT-B heading south inaccessible due to damage to vault.
  - <u>December 15</u>: removed manhole cover at northeast corner of the Precipitation Plant with a mini-backhoe to gain access to sewer lines UT-T/-U. Used sonde to connect UT-D from east and west access points. Significant sediment prevented much video inspection of UT-D. New pipe identified near UT-D that heads north then east from the northwest corner of the Precipitation Plant. Blocked at 37 feet. Began video inspection of UT-F.
  - <u>December 16</u>: continued video inspection of UT-F but progress limited to about 40 feet from accessible openings due to significant corrosion/degradation of bottom of piping. Attempted to video UT-C, but progress limited due to significant sediment in pipe. Attempted to video UT-N, but clay pipe blocked or crushed near opening. Completed video of UT-O for 55 feet going west and 60 feet east from manhole near Blue Shop; pipe in good condition with some sediment. Completed video of UT-O for 40 feet west from exit point on berm; sediment limited further progress. Attempted to video UT-K, but it is rusted and full of debris. Attempted to video new pipe identified from Truck Shop sump. Entry from the east was limited by water, debris, and oily sludge.

- <u>Phase I Remaining Activities</u>: Pending discussions with EPA, additional assessment efforts may include the location of Dry Well #5, portions of the Weed Heights Sewer (UT-V), portions of sewer lines UT-R/-S west of the Truck Shop, and intrusive exploration in select areas based on the results of EM-31/-61 surveys.

- <u>Phase II</u>: Phase II activities will be scheduled and conducted following a technical meeting between EPA, ARC and Spectrum to discuss the results of Phase I. Phase II activities are tentatively scheduled for February 2011.

As indicated above, Spectrum is anticipated to provide a draft technical report that summarizes the results of Phase I investigations by second or third week of January 2011. A meeting with EPA, ARC and Spectrum to discuss results and plan for any additional geophysical surveys in the Process Areas should be held in early February 2011 to formulate the strategy for subsequent field surveys.